Warming responses of native plants, *Ranunculus acris* and *Thymus praecox* ssp. *arcticus* in geothermal areas, Iceland

Applicant: Nia Perron

STSM Type: Regular

Period for the mission: 12-17th March, 2017

STSM Topic: Joint Ecosystem Assessment on the Effect of Natural Soil Warming on Subarctic Grasslands and Forests

Host: Andreas Richter, University of Vienna, Vienna (AT)

Reference: COST-STSM-ES1308-36870

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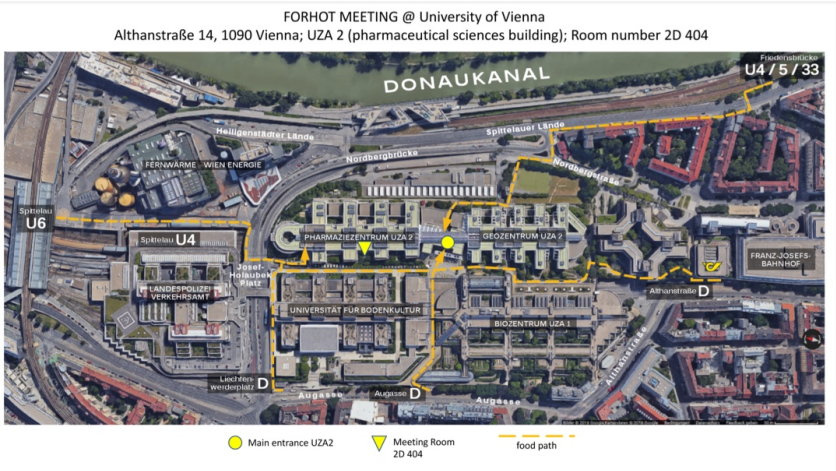

Figure 1: Location of the workshop/conference

Purpose

The aim of the Short Term Scientific Mission (STSM) was to participate in the ***Joint Ecosystem Assessment on the Effect of Natural Soil Warming on Subarctic Grasslands and Forest*** conference and workshop. The purpose of attending the conference/workshop was to gain experience and knowledge that will be used for publication of a paper. One of the main goals of the workshop is to help and encourage young scientists to publish their research by offering instruction, constructive criticism and support during the three-day event.

Description of the work carried out during the STSM

As the applicant, I attended the 2017 workshop/ conference Joint Ecosystem Assessment on the Effects of Natural Soil Warming on Subarctic Grasslands and Forests which took place between March 13 - 15th, 2017. The workshop/ conference was divide into several sections. The sections included a mini-conference, in-depth sessions, directed discussions (1-5), a business meeting, and social events. The last day of the STSM was used for taking the information and applying it to my individual research (Table 1).

Mini-conference

The mini-conference took place during the second and third day of the STSM. The purpose was for participants of the consortium to present their research. ForHot, like many other research consortiums, bring together individuals from several different institutions. Currently, 30 researcher or postdocs, and 18 graduate, MSc and PhD students are involved in the ForHot project. As the number of partners involved in a project increases, it becomes important to ensure that those involved are aware of the different studies being conducted in the same area. Open communication will allow for increased collaboration and data sharing; the exact intent of the mini conference.

The conference was organized by dominant themes. For the first day, the themes were "Conquests of the Belgium army" and "The tree huggers". Talks from the first theme were focused on the large amount of work that has come out of the researchers based in Antwerp. This included an overview of Leblans' recently published PhD dissertation, the 2016 pulse labelling campaign, a study determining the role of soil warming on the metabolic quotients of soil microorganisms, and an overview/ discussion about the conditions of the site throughout 2016. Speakers from the first theme included: Ivan Janssens (Univ. Antwerp), Niki Leblans (Univ. Antwerp), Erik Verbruggen (Univ. Antwerp, Dajana Radujkovic (Univ. Antwerp), Sara Marañón (Universitat Autònom a de Barcelona) and Gunnhildur E. G. Gunnarsdóttir (Agric. Univ. of Iceland)

Table 1: Timeline of STMS

Day 1 (March 12th)
• Travel from Iceland to Vienna • Brief meet up with hosts to prepare for the following day
Day 2 (March 13th)
• Meet and greet with all the participants • Mini- conference: Research highlights
Day 3 (March 14th)
• Mini- conference: Research highlights continued • Presonal presentation: My contribution to the ForHot consortium • Discussion Activities 1-3 • Workshop dinner
Day 4 (March 15th)
• Discussion Activities 4 & 5 • Sessions 2 to 4 • Brainstorming session • ForHot business meeting
Day 5 (March 16th)
• Compiling information and applying it to individal project
Day 5 (March 17th)
• Travel day

The second theme highlighted research that had a direct effect on the forested site part of Forhot area. Talks included an overview of Pall Sigurdsson's (Agric. Univ. of Iceland) PhD project, Ivika Ostonen's (Univ. of Tartu) work investigating the role of soil warming on carbon root exudation and soil carbon dynamics, Per Gundersen's (Copenhagen Univ.) examination of soil warming and increased leaching losses, Martin Maddson's (Univ. of Tartu) measurements of N2 emissions in warmed soils, Marja Maljanen's (Univ. Eastern Finland) controversial flux measurements and Hans Sandén's (BOKU) investigation into the temperature sensitivity of soil enzymes.

Figure 2: Some of the participants in Vienna (photo courtesy of Bjarni Sigurdsson).

Day two of the mini-conference maintained the soils theme with "More on soil function and microbial ecology" but also diverged to talk about above ground processes with "Bugs and Biodiversity". Tom Walker and Andreas Ritcher (Univ. of Vienna) talked about the research being done to investigate the role of soil temperature on soil microbes, Josep Peñuelas (Universitat Autònom a de Barcelona) explained the impact of soil warming on the soil metabolome, Håkan Wallander & Jing Zhang (Lund University) presented information about their soil fractions and C and N isotope data, while Alf Ekblad, Jing Zhang & Håkan Wallander (Lund University) talked about their research into the biomass of arbuscular mycorrhiza in the new and old grassland sites.

The final group of talks in the mini-conference, under the theme "Bugs and Biodiversity" was kicked off by Anna Daebeler (Univ. of Vienna) who presented her results from a fertilization experiment in GO, Nicholas Rosenstock & Håkan Wallander et al. (Lunf University) talked more about the relationship between microriza and soil warming in the Forhot forest, Martin Holmstrump (Aarhus Univ.) presented a summary from his most recent publication submission regarding the effects of soil warming on the functional diversity of Collembola in long term and short term plots, Bryndis Marteinsdottir (University of Iceland) highlighted the future projects that are planned to study the effects of soil warming on vegetative plant communities, and I gave my presentation: Warming responses of two native Icelandic plants *Ranunculus acris* and *Thymus praecox* ssp. *arcticus* in geothermal areas.

My Contribution to the ForHot consortium

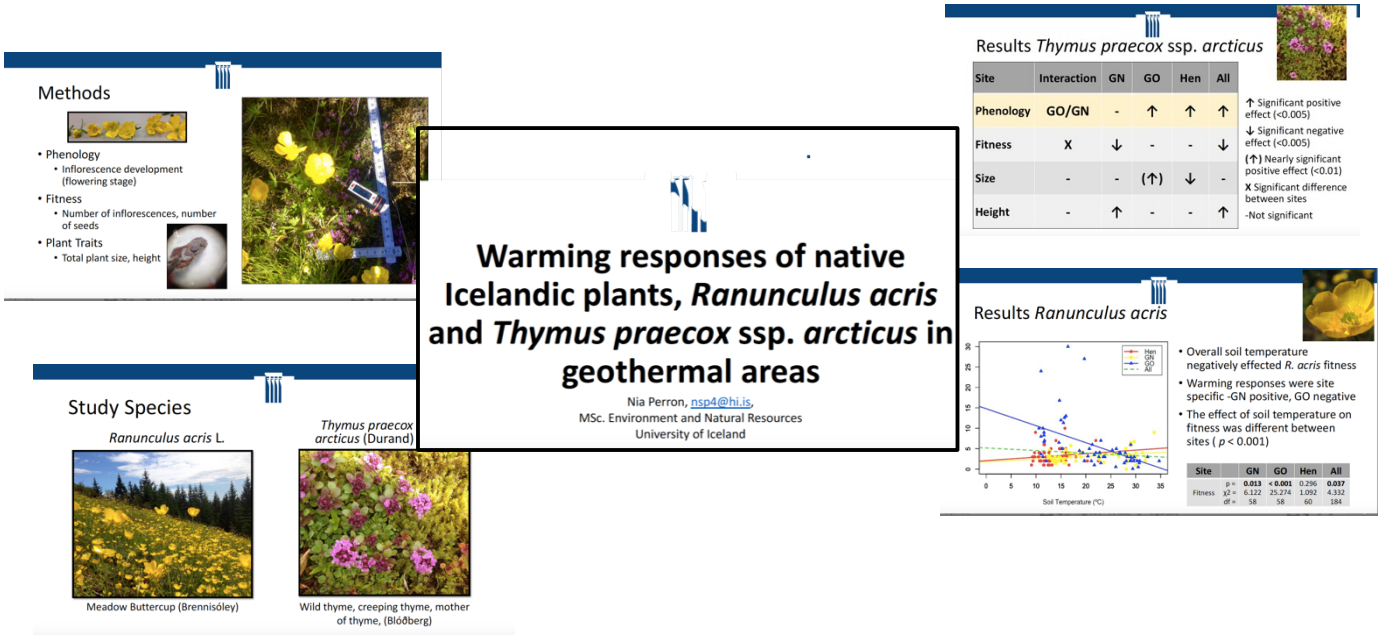

Figure 3: Slides from my presentation given on March 14th, 2017

One of the main objectives behind the STSM and attending the workshop/ conference in Vienna was to present the work that has resulted from my MSc thesis dissertation. The STSM provided me with the opportunity to showcase my contribution to the Forhot research initiative through an oral presentation that I gave as part of the mini-conference. The talk lasted 10 minutes, with five additional minutes for questions, comments and discussion.

My project was framed within the context of anthropogenic climate change. Increases in global average temperature, ranging from 0.3 - 4.8ºC by 2100 (IPCC, 2014), will result in increased soil temperatures. My objective was to determine how native Icelandic plants, *Ranunculus acris* and *Thymus praecox* ssp. *arcticus* respond to soil warming, and if their responses depend on elevation and/or time since warming. The study areas (GN, GO and Hengill) provide natural temperature gradients within a small geographic area where soil temperature can be isolated from other variables i.e. space, time and biological complexity. Each site has soil temperatures ranging from ~8ºC to 48ºC and exhibit differences in elevation and time since warming. Plant phenology, fitness and functional traits were measured for both species at each site. Linear mixed models were used to determine the relationship between plant traits and soil temperature. Warming responses were species and site specific. At GN, temperature effected fitness (positive for *R. acris*, negative for *T. praecox*) and height (negative for *R. acris*, positive for *T. praecox*). At GO temperature had a negative effect on *R. acris* fitness, size and height and a positive effect on *T. praecox* phenology. In Hengill temperature had a positive effect on *T. praecox* phenology but a negative effect on plant size. This is one of few studies determining the influence of soil warming on plant growth exclusively, using natural thermal gradients and will help establish species tolerance to warming soils.

Overall it was a meaningful opportunity. I was able to link my findings to some of the other research, and highlight areas that might need more attention. For example, I spoke to how my results showed earlier flowering emergence for one of my two study species, similar to what have been observed with NDVI measurements and other small scale population studies coming out of the area (Sigurdsson et al. 2016). I was also able to offer non-empirical evidence that sheep grazing was worth considering as an external variable in the ForHot sites.

Sessions 1 – 3

Session 1

Session 1 was intended to discuss our current understanding of the general status of the ForHot research sites and identify key gaps in our current understanding/research. This included improvements to the ForHot infrastructure and data collection. For example, one point of consensus among the group was that the ForHot members need to focus their efforts on data modeling, being a major weak point for the project.

This session also identified new measurements that are required at ForHot, including air samples for flux measurements, 12CO2 and 13CO2, as well as plant samples for N15 and 13C sampling. Finally, the first session highlighted the action plan for the 2017 summer field season.

Session 2

The second session outlined the new project that has been proposed for the Forhot area. Plant-soil carbon responses to warming and nitrogen 2017-2019. The session included an introduction and discussion about the new ForHot-related FWO-funded Belgium/ Austria project.

Session 3

The third session was a brainstorm session, in which we discussed our current understanding of the ForHot microbial ecology and key gaps in our current understanding/research. This session was lead by the host of the conference, Andreas Richter.

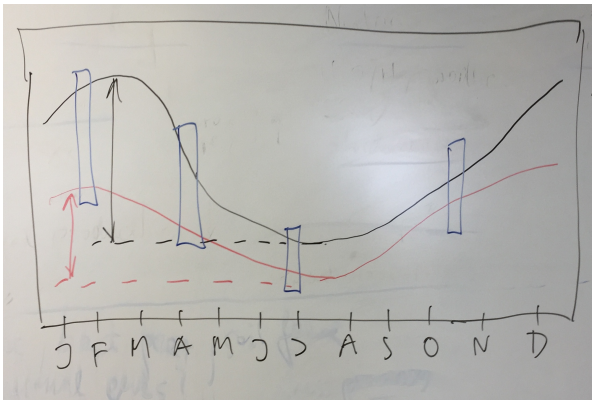

Figure 4: Set-up of a future experiment with four intensive sampling occasions (bars) and up to eight standard ones (lines). Black lines indicate microbial biomass in unwarmed conditions. Red lines indicate microbial biomass in +10 °C treatment.

Discussion Activities 1 – 5

The discussion activities took place on the third and fourth days of the STSM. Discussions one through five were longer than the talks during the mini-conference. They were designed to highlight specific and important research initiatives in Forhot that are either in the publishing, or the planning phase. The goal was to encourage discussion among participants, to see ways to

improve upon the research being produces. Included in the discussion was the new three year postdoc project that will be conducted at ForHot and the Nature SOC paper by Leblans et al.

Forhot Business Meeting

The final part of the workshop/conference was the ForHot Business Meeting. This was a roundtable discussion about all ongoing and future project/publication plans and decisions that need to be reached at the meeting. General discussion on future collaborative research within the ForHot project (and outside) and list of publications for 2017-2018 was prepared.

Self-Directed Work

On the final day of the STSM I was able to do self directed work to apply everything the ideas and concepts that I learnt from the conference into my research. At the National Library of Vienna, I worked on my research independently but with the guidance provided by the researchers from the previous days.

One of the big questions I came away with is: Can I incorporate any of the unpublished data from Forhot into my study to improve upon its quality and scope? For example, there have been extensive measurements of NDVI throughout 2016, as well as in years previously. My research is, for a large part a phenology study. Therefore, it would be logical to use this important data within my research.

Figure 5: National Library Austria. Library ceiling, Alfreddiem/FLICKR (Creative Commons)

More questions that came up that I worked into my research were:

How does the belowground soil microbe community influence my results?

What was the influence of soil nutrients?

Are other factors, such as herbivory and pathogens influencing the study plants?

Can we identify a temperature tipping point for the traits measured?

Future Collaboration with the Host Institution

I was very interested in the idea of open data sharing emphasized at the meeting. I would be very interested in collaborating with the ForHot consortium to ensure that any and all relevant raw data from my research is readily available for use. Additionally, I will be working near the ForHot area again this summer and will be available to provide support within the field for any campaigns that might be taking place, time permitting of course.

Foreseen Publications from the STSM

As participation in the conference, I have committed to the submission of a publication. With the assistance from my advisor, I intend to start the submission processes once the thesis dissertation in completed in June. The paper will focus on the effect of soil warming on plant traits throughout the ForHot sites. Working title: *Warming responses of native plants, Ranunculus acris and Thymus praecox ssp. arcticus in geothermal areas, Iceland.* I will also be communicating my work through either a talk or poster at the 6th Annual Conference for the Ecological Society of Iceland

Takeaway

The conference and workshop facilitated by the STSM was an incredible opportunity for me to expand myself as a student and researcher. It provided me with constructive feedback that will that will help me to improve upon my project. The STSM also provided me with the opportunity to experience large scale and effective research collaboration first hand. In a lot of ways, it was inspiring to see so many prominent research from different field come together to work towards a similar mission. I would hope to be a part of a team similar to this in my career future.

Confirmation by Host Institution

See document attached.

References

IPCC: Barros, Vicente R., Christopher B. Field, David Jon Dokken, Michael D. Mastrandrea, and Katharine J. Mach, eds. 2014. *Climate Change 2014: Impacts, Adaptation and Vulnerability: Working Group II Contribution to the IPCC Fifth Assessment Report of the Integovernmental Panel on Climate Change*. Cambridge: Cambridge University Press. http://ebooks.cambridge.org/ref/id/CBO9781107415386.

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